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A New Species of *Lysiphlebus* Förster 1862 (Hymenoptera: Braconidae, Aphidiinae) Attacking Soybean Aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae) from China

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Abstract.—***Lysiphlebus orientalis* sp. n.** is described from China. The new species was reared from *Aphis glycines* Matsumura/ *Glycine max* association. On the basis of the fore wing venation pattern (short R1 vein) and the number of maxillary and labial palpomeres, we can preliminarily classify *L. orientalis* sp.n. as a member of the "*testaceipes* Cresson" species-group. Laboratory populations of *L. orientalis* are thelytokous, the first record of this phenomenon in this species group.

Key words.—*Lysiphlebus orientalis sp.n.*, aphid parasitoids, *Glycine max*

The soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), is native to northeast Asia (China, Korea and Japan) but was discovered infesting soybean fields in North America beginning in summer 2000 (Venette and Ragsdale 2004) and has become a serious pest throughout soybean-growing areas of the Midwest (Ragsdale et al. 2004, 2007). These aphids not only devastate soybean plants by direct feeding, but they also spread plant-pathogenic viruses (Halbert et al. 1986; van den Berg et al. 1997; Wang et al. 1994).

In Asia, the soybean aphid is attacked by braconid and aphelinid parasitoids (Chang et al. 1994; Wu et al. 2004b; Liu et al. 2004; Miao et al. 2007). The main natural enemies of soybean in North America are native and naturalized predators, including lady beetles, minute pirate bugs and predatory flies (Fox et al. 2004, 2005; Rutledge et al. 2004; Rutledge and O'Neil 2005; Costa-

magna and Landis 2006, 2007; Desneux et al. 2006; Donaldson et al. 2007; Gardiner and Landis 2007; Chacon et al. 2008; Costamagna et al. 2008; Gardiner et al. 2009). Parasitoids attacking soybean aphid in North America have been rare, on the other hand (Lin and Ives 2003; Kaiser et al. 2007; Noma and Brewer 2008; Pike et al. 2007), with the exception of relatively high parasitism by aphidiine braconids reported in New York state (Nielsen and Hajek 2005) and also by *Aphelinus certus*, an accidentally-introduced species, in eastern North America (Heraty et al. 2007; Heimpel et al. in press).

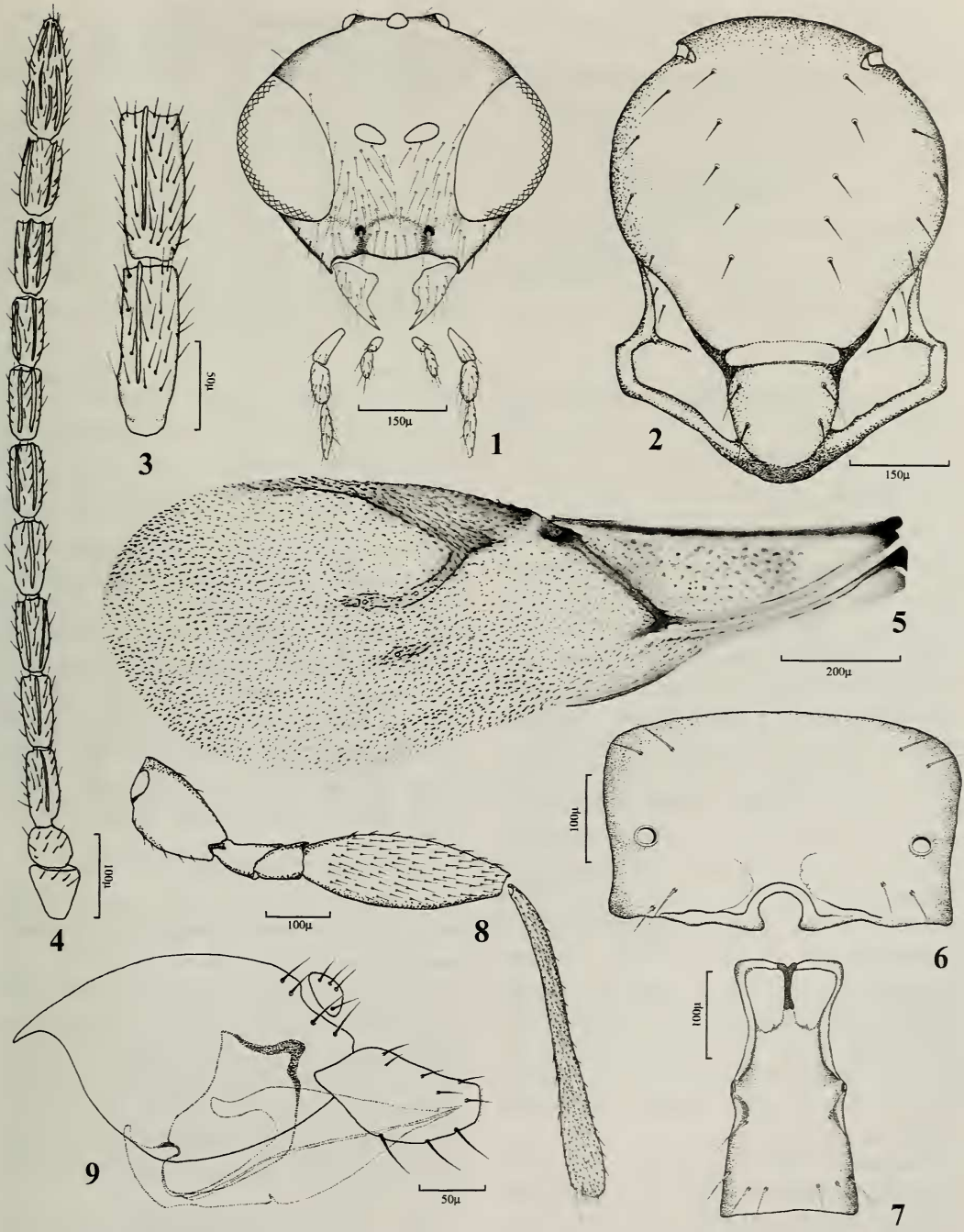
Initial biological control efforts directed at the soybean aphid have resulted in the importation of several aphid parasitoids and predators from China, Japan and South Korea into quarantine, including a strain of an aphelinid parasitoid from Japan in 2001 (Heimpel et al. 2004; Wu et al. 2004a) and at least two species of the aphidiine braconid genus *Binodoxys* (Wyckhuys et al. 2007; Desneux et al. 2009a; Desneux et al. 2009b). In addition to these species, recent ongoing research on the introduction of the braconid parasitoids of soybean aphid from China has yielded the discovery of a new species of *Lysiphlebus* Förster contributing to our current revisionary work on the subtribe Lysiphlebina Mackauer. Here we describe the new species and discuss its identity and possible distributional pattern.

MATERIAL AND METHODS

Parasitoids were obtained by collecting samples of *Glycine max* plants colonized by *A. glycines* in commercial and experimental fields in China. Collections at field sites in northeastern Chinese provinces were made by K. Hoelmer, J. Yu and M. Wang during June, July and August of 2006 in the vicinity of Harbin, Heilongjiang province, and Xiuyan, Liaoning province. Leaves and stems of plants with aphid colonies were cut, placed into plastic zip-lock bags and held in chilled picnic coolers while in the field, then transferred to the laboratory where they were kept in containers covered with nylon mesh at room temperature during sample processing. Emergent adults were collected in vials and mummified aphids containing developing parasitoids were placed individually in wells of plastic microtiter plates and sealed with corks for shipment. Vials with adults were streaked with honey, and each microtiter plate well was given a small droplet of honey to sustain adults that emerged during transit. Parasitoids were shipped to the USDA ARS biological control quarantine laboratory in Newark, Delaware, USA. Quarantine cultures of *A. glycines* parasitoids were initiated at Newark from these shipments and maintained on *A. glycines* on soybean. After establishment, a portion of the cultures were transferred to the University of Minnesota, USA to support host range evaluations. The new species of *Lysiphlebus* was discovered during these evaluations. Slides were made of dissected specimens using Hoyer's media. External morphology was studied using an Olympus SZX9 stereomicroscope. Illustrations were made based on slide-mounted specimens using an Olympus BH2 Phase-contrast microscope with a drawing tube. Morphological terminology follows Starý (1973) and Sharkey and Wharton (1997). Subdivisions of the flagellum are referred to as segments in order to maintain consistency with other taxonomic works on Aphidiinae. Measurements in the description were taken using an ocular micrometer. See Tomić et al. (2005) for more details regarding measurements.

RESULTS

Diagnosis.—On the basis of the fore wing venation pattern (short R1 vein, which is equally or slightly shorter than the stigma) (Fig. 5) and the number of maxillary and labial palpomeres (three maxillary and two labial palpomeres) (Fig. 1), we preliminarily classify *Lysiphlebus orientalis* sp.n. as a member of the "*testaceipes* Cresson" spe-



Figs 1–9. *Lysiphlebus orientalis* sp. n., female paratype. 1, head and mouthparts; 2, mesoscutum; 3, first and second flagellar segments; 4, antenna; 5, fore wing; 6, propodeum; 7, petiole; 8, hind leg; 9, genitalia.

cies-group. *Lysiphlebus orientalis* sp. n. differs from the nominate species *L. testaceipes* by having a smaller number of antennal segments (*L. orientalis* sp. n. has 12-segmented antennae vs. 13–14-segmented antennae of *L. testaceipes*). Also, flagellomeres 1 and 2 of *L. orientalis* sp. n. bear 1–2 and 2–3 longitudinal placodes, respec-

tively, but *L. testaceipes* has 4–6 longitudinal placodes on flagellomere 1 and 5–7 on flagellomere 2. *Lysiphlebus orientalis* sp. n. has an elongately triangular stigma (stigma length/width ratio of 2.9–3.2), but *L. testaceipes* has a widely triangular stigma (stigma length/width ratio of 2.4–2.6). In addition, *L. orientalis* sp. n. differs from all other species in having short marginal fore wing setae. All other species of the "*testaceipes*" species-group have long marginal fore wing setae.

***Lysiphlebus orientalis* Starý & Rakhshani sp. n.**

(Figs 1–12)

Description

Female: Head (Fig. 1) transverse, wider than mesosoma at tegulae, bearing sparse setae. Eyes medium sized, oval, laterally prominent. Face laterally pubescent. Tentorial index (tentoriocular line/intertentorial line) 0.49–0.50, Clypeus slightly protruding with 5–6 long setae. Labrum distinct, with 2 short setae on outer margin. Malar space equal to 0.28–0.30 of longitudinal eye diameter. Mandible bidentate, with 7–9 setae in outer surface. Maxillary palpi with 3 palpomeres, labial palpi with 2 palpomeres. Antenna 12-segmented (scape and pedicel as primary segments and 10 flagellomeres), filiform (Fig. 4). Pedicel subsphaerical. F_1 (Fig. 3) equal or slightly longer than F_2 and 2.2–2.6× as long as its maximum width. F_1 and F_2 bearing 1–2 and 2–3 longitudinal placodes respectively (Fig. 3). Flagellomeres covered uniformly with semi-erect setae.

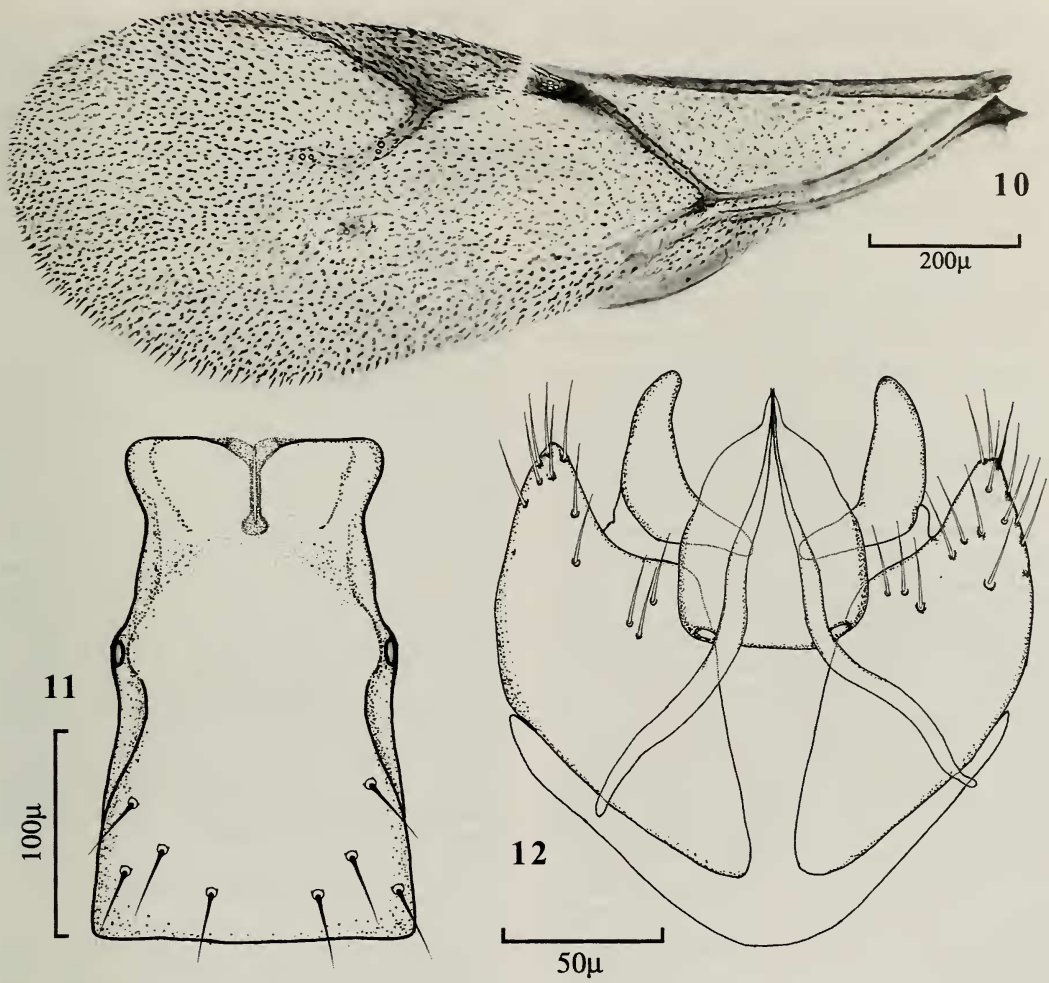
Mesosoma - Mesoscutum (Fig. 2) smooth, covering pronotum from above; notaulices distinct in ascedent portion of anterolateral margin, effaced dorsally, with 6–7 long setae along laterodorsal part of mesoscutum. Scutellum subquadrate, bearing 2 long setae at each lateral margin. Propodeum (Fig. 6) smooth, with two divergent carinae at base, (some specimens manifest indications of "pseudo-carination" or rugosities in upper part of propodeum, establishing incomplete central areola). Upper and lower parts of propodeum with 2–3 and 1–2 long setae on each side. Fore wing (Fig. 5) densely pubescent, lower marginal setae short, equal to those on surface; stigma, 2.9–3.2× as long as its width, 1.00–1.27 as long as R1 vein (=metacarpus). R_1 vein 1.35–1.40× as long as R_2 vein, 2.00–2.10× as long as rs-m vein. Hind femur with short adpressed setae (Fig. 8).

Metasoma - Petiole (Fig. 7) elongate, smooth, slightly convex dorsally, with lateral depression after prominent spiracular tubercles, positioned midsegment; its length 2.00–2.25× its width at spiracles, 1.50–1.70× its width at base; 4–5 setae positioned on posterior laterodorsal margin, one long seta posterior to spiracles. Ovipositor sheath (Fig. 9) short, wide at base, dorsally slightly convex, narrowed toward tip, apically truncated, bearing four long setae at tip and 4–5 shorter scattered setae on lateral and dorsal surface. Length of ovipositor sheath 1.8–2.0× its maximum width at base, 4.2–4.4× its minimum width at tip. Second valvula with smooth dorsal outline.

Body length: 1.5–1.7 mm

Coloration: General body color light brown, head and antenna light brown, mouthparts except tips of mandible yellowish. Pronotum brown; mesoscutum and mesopleuron dark brown. Propodeum brown. Legs yellow, hind leg with brown dorsal outlines. Wings hyaline, venation yellowish brown. Propodeum brown. Petiole yellow, other metasomal terga light brown, dorsally darker. Ovipositor sheath dark brown.

Male: Antenna 14-segmented. Maxillary palpi with 3 palpomeres, labial palpi with 2 palpomeres. Fore wing venation as in female (Fig. 10). Fore wing lower marginal setae distinctly longer than those on surface; stigma widely triangular, 2.8–3.1× as long as its width. Petiole (Fig. 11) elongately quadrangular, 1.75–1.85× its width



Figs 10–12. *Lysiphlebus orientalis* sp. n., male. 10, fore wing; 11, petiole; 12, genitalia.

at spiracles, with lateral depression after spiracular tubercles. Aedeagus subtriangular (Fig. 12) with subparallel posterolateral margins and short tip. Body darker than female, head and thorax black brown, antenna dark brown, mouthparts yellowish brown. Wings slightly translucent. Legs brown with light yellow patches at ventral and tip of segments. Petiole light brown, other metasomal segments greyish brown. Body length: 1.5–1.6 mm.

Material

Holotype: ♀ reared from *Aphis glycines* Matsumura on *Glycine max* (L.) Merrill, CHINA, Harbin, VIII 2006, Leg. K. Hoelmer, laboratory culture, reared on *Aphis glycines* on *Glycine max*, University of Minnesota, USA, 2008, G. E. Heimpel (Collection of United States National Museum of Natural History).

Paratypes (same sampling data as holotype): 3♀ and ♂ paratypes are deposited in the collection of United States National Museum of Natural History. 6♀ paratypes are deposited in the collection of P. Starý (České Budějovice). 3♀ paratypes are deposited in the collection of Institute of Zoology, Chinese Academy of Sciences, Beijing, China. 7♀ and 2♀ paratypes are deposited in the collection of Institute of Zoology, Faculty of Biology, University of Belgrade (Serbia) and in collection of University of Zabol (Iran), respectively.

Additional material: 20♀ and 2♂ with same sampling data as holotype deposited in the collection of Institute of Zoology, Faculty of Biology, University of Belgrade (Serbia).

DISCUSSION

Lysiphlebus orientalis n. sp. is a new member of the "*testaceipes*" species group, a tentative taxon which has previously been classified within subgenus *Phlebus* (Starý 1975). The group includes the species distributed within a specific geographic area of which only *L. testaceipes* Cresson has a wider distribution, assumed to be due to introduction and expansion of its range in combination with its opportunistic host range (Kavallieratos and Lykouressis 1999, 2004; Kavallieratos et al. 2001; Pons et al. 2004; Starý et al. 2004). Originally believed to be a North American species, *L. testaceipes* has also been recovered from the east Palaearctic (Starý et al. 2002). The known distribution of *L. orientalis* is northeast China, but further research may document a broader distribution. Other taxa which should be preliminarily included in the "*testaceipes*" group are: *L. fritzmuelleri* Mackauer (Europe), *L. desertorum* Starý (Central Asia), *L. ussuriensis* Kiriac (Far East) and *L. utahensis* (Smith) (Nearctic).

Examination of the field-collected specimens revealed a highly skewed female: male sex ratio. However, laboratory cultured material comprised a mostly or completely uniparental population, a phenomenon that has not been previously recorded in any member of the *testaceipes* group, although it occurs in other *Lysiphlebus* species, namely *L. fabarum* (Marshall), *L. cardui* (Marshall), and *L. confusus* Tremblay and Eady (Belshaw et al. 1999; Starý 1999; Starý et al. 2002), which belong to the subgenus *Phlebus* Starý. Further investigations are needed to elucidate the nature and distribution of thelytoky in the respective groups.

Our ongoing research on the subtribe Lysiphlebina Mackauer reveals several *Lysiphlebus* species in Europe that are putatively related to *L. orientalis* sp.n. on the basis of morphological characters. We shall resolve the taxonomic status of the aforementioned *Lysiphlebus* taxa and their possible relations with *L. orientalis* sp.n. using molecular markers in a future contribution.

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